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NATIONAL DAM SAFETY PROGRAM. LAKE FOREST DAM (MO30087), MISSISS--ETC(U)
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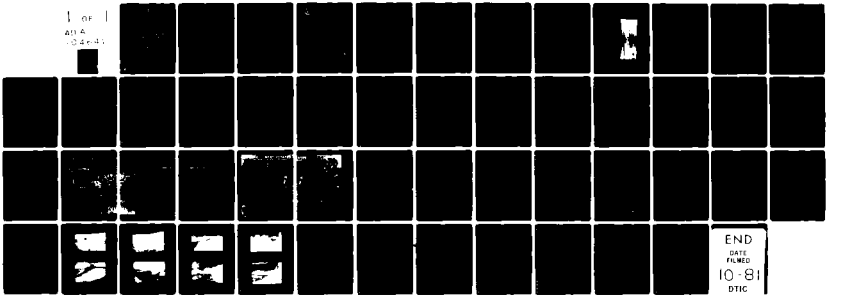

LEVEL II

MISSISSIPPI - KASKASKIA - ST. LOUIS BASIN

LAKE FOREST DAM,
STE. GENEVIEVE COUNTY, MISSOURI
MO 30087

PHASE 1 INSPECTION REPORT NATIONAL DAM SAFETY PROGRAM

PREPARED BY: U. S. ARMY ENGINEER DISTRICT, ST. LOUIS

FOR: STATE OF MISSOURI

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DECEMBER 1978

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Dam Safety, Lake, Dam Inspection, Private Dams

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

This report was prepared under the National Program of Inspection of Non-Federal Dams. This report assesses the general condition of the dam with respect to safety, based on available data and on visual inspection, to determine if the dam poses hazards to human life or property.

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DEPARTMENT OF THE ARMY
ST. LOUIS DISTRICT, CORPS OF ENGINEERS
210 NORTH 12TH STREET
ST. LOUIS, MISSOURI 63101

REPLY REFER TO

C

SUBJECT: *Lake Forest Dam*

This report presents the results of a field inspection and an evaluation of the Lake Forest Dam.

It was presented under the National Program of Inspection of Non-Federal Dams.

This dam has been classified as unsafe, non-emergency by the St. Louis District as a result of the application of the following criteria:

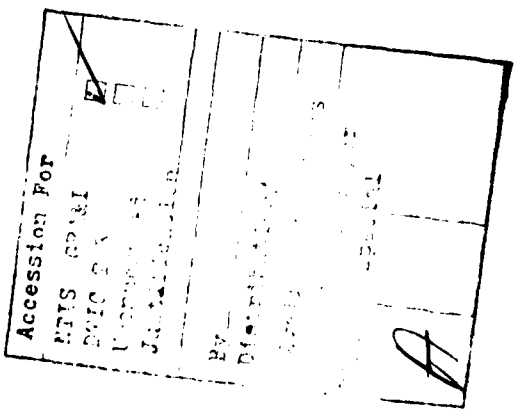
1) Spillway will not pass 50 percent of the Probable Maximum Flood.
2) Overtopping could result in dam failure.
3) Dam failure significantly increases the hazard to loss of life downstream.

SUBMITTED BY: SIGNED
Chief, Engineering Division

19 DEC 1978
Date

APPROVED BY: SIGNED
Colonel, CE, District Engineer

20 DEC 1978
Date



LAKE FOREST DAM
STE. GENEVIEVE COUNTY, MISSOURI

MISSOURI INVENTORY NO. 30087

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

Lake Forest Dam ([redacted] MO-30087), Mississippi-Kaskaskia-St. Louis Basin, Ste Genevieve County, Missouri. Phase I Inspection Report.

PREPARED BY:

HORNER & SHIFRIN, INC.
5200 OAKLAND AVENUE
ST. LOUIS, MISSOURI 63110

FOR:

U.S. ARMY ENGINEER DISTRICT, ST. LOUIS
CORPS OF ENGINEERS

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PHASE I REPORT

NATIONAL DAM SAFETY PROGRAM

Name of Dam:	Lake Forest Dam
State Located:	Missouri
County Located:	Ste. Genevieve
Stream:	Big Bottom Creek
Date of Inspection:	9 August 1978

The Lake Forest Dam was visually inspected by engineering personnel of the office of Horner & Shifrin, Inc., Consulting Engineers, St. Louis, Missouri. The purpose of the inspection was to assess the general condition of the dam with respect to safety and, based upon this inspection and available data, determine if the dam poses a hazard to human life or property.

The following summarizes the findings of the inspection and the results of certain hydrologic/hydraulic investigations performed under the direction of the inspection team.

Based on a visual inspection, the present general physical condition of the dam and spillway is considered satisfactory; however, the following deficiencies were noticed during the inspection and are considered to have an adverse effect on the overall safety and future operation of the dam and spillway:

1. A moderately dense cover of vegetation that may contain animal burrows and several small trees are present on the downstream face of the dam. Tree roots and animal burrows can provide passageways for seepage that could develop into a piping condition.

2. A light growth of vegetation extending above the waterline exists in the lake at the approach to the spillway. This growth may reduce the spillway discharge capacity since the flow approaching the spillway would be impeded.

3. At the time of the inspection, it could not be determined if the 6-inch sanitary sewer and the 14-inch diameter drawdown pipe passing beneath the dam could be isolated if necessary in order to prevent loss of foundation soils, should collapse of the sewer or pipe beneath the dam occur. Voids resulting from loss of materials into the conduit will provide a passageway for seepage that may develop into a piping condition and subsequent failure of the dam.

The conditions described above are not considered to be serious at this time.

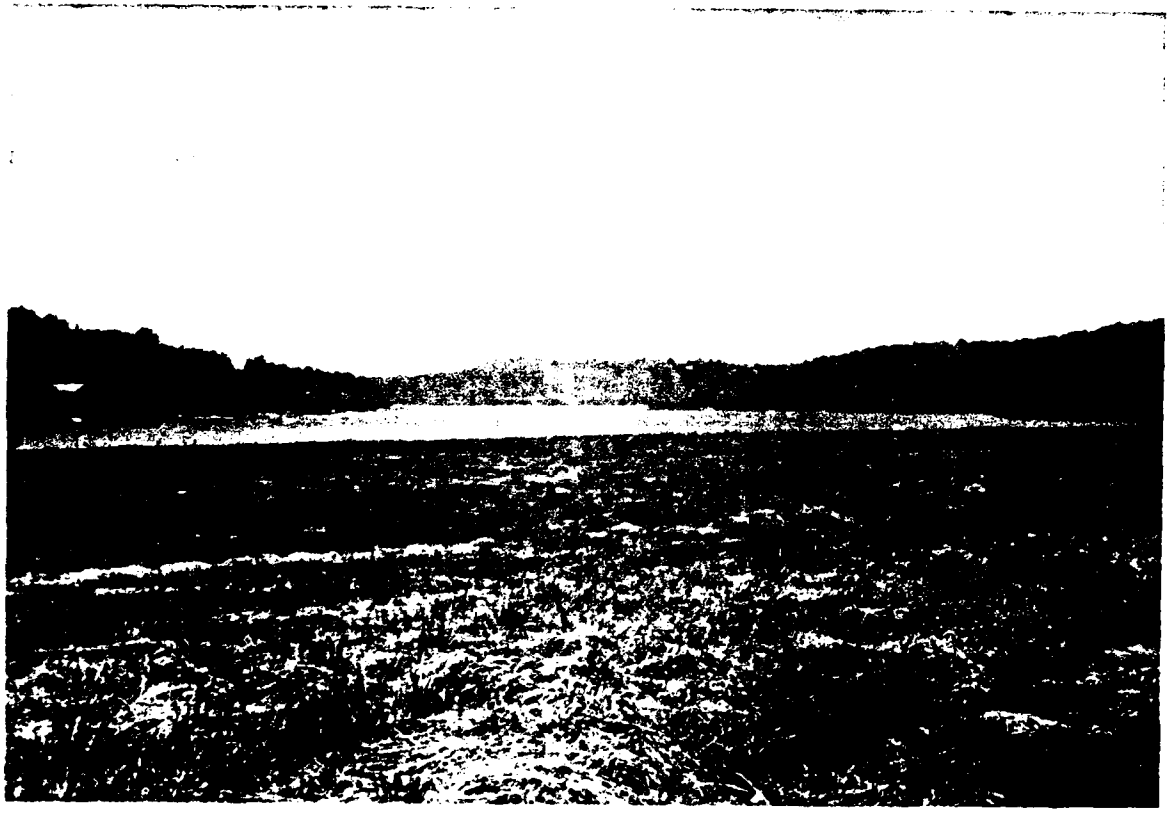
The crest of the dam was found to be approximately 5 feet lower at a point near the center of the dam than in the area adjacent to the spillway. (The low point of the dam is approximately 9 feet higher than the spillway crest.) As a result, the capacity of the spillway to discharge lake outflow without overtopping the dam is reduced. According to the criteria set forth in the recommended guidelines (see text) the minimum spillway design flood for this dam, which is classified as intermediate in size and of high hazard potential, is specified to be the Probable Maximum Flood (PMF). PMF is the flood that may be expected from the most severe combination of critical meteorologic and hydrologic conditions that are reasonably possible in the region. Results of a hydrologic/hydraulic analysis indicated that the existing spillway is inadequate to pass the lake outflow resulting from a storm of PMF magnitude. It is capable of passing the lake outflow resulting from the 1 percent chance (100-year frequency) flood. The spillway is capable of passing lake outflow corresponding to approximately 22 percent of the PMF without overtopping the dam. The length of the downstream damage zone, should failure of the dam occur, is estimated to be ten miles. There are at least two houses and one bridge crossing within the first two miles downstream of the dam.

A review of available data did not disclose that seepage and stability analyses of the dam were performed. This is considered a deficiency and should be rectified.

It is recommended that the Owner take the necessary action in the near future to correct or control the deficiencies and safety defects reported herein.

Albert B. Becker, Jr.

Albert B. Becker, Jr.
P.E. Missouri E-9168



OVERVIEW OF LAKE AND DAM

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM
LAKE FOREST DAM - ID NO. 30087

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PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

LAKE FOREST DAM - ID NO. 30087

SECTION 1 - PROJECT INFORMATION

1.1 GENERAL

a. Authority. National Dam Inspection Act, Public Law 92-367, dated 8 August 1972.

b. Purpose of Inspection. The purpose of this visual inspection was to make an assessment of the general condition of the dam with respect to safety and, based upon available data and this inspection, determine if the dam poses a hazard to human life or property.

c. Evaluation Criteria. This evaluation was performed in accordance with the "Phase I" investigation procedures as prescribed in "Recommended Guidelines for Safety Inspection of Dams," Appendix D to "Report of the Chief of Engineers on the National Program of Dams," dated May 1975.

1.2 DESCRIPTION OF PROJECT

a. Description of Dam and Appurtenances. The Lake Forest Dam is an earthfill type embankment rising approximately 46 feet above the original stream bed. The dam has a crest width of 38 feet with embankment slopes of 1v on 3h upstream and 1v on 2h downstream. The upstream side of the dam has a twenty foot wide berm near the normal pool elevation. A gravel road with a bridge crossing the spillway traverses the dam crest. A concrete boat launching ramp is installed on the upstream face of the dam near the spillway. The lake level is governed by an uncontrolled spillway which has been cut into rock at the left abutment. The spillway channel is "U" shaped with a bottom width of approximately 30 feet. A short series of rock falls is located in

the spillway exit channel approximately 450 feet downstream of the crest. The spillway channel joins Big Bottom Creek immediately downstream of the rock falls. A 14-inch diameter steel pipe, located near the center of the dam, serves the lake for drawdown purposes. A channel with cement stabilized side slopes conducts flow leaving the lake drawdown pipe downstream to a point where it joins the original stream. A series of sewage treatment lagoons is located approximately 80 feet downstream of the toe of slope. At normal pool elevation, the lake occupies approximately 87 acres. A plan of the Lake Forest Estates Development, showing the lake, dam and lagoons, is shown on Plate 2.

b. Location. The dam and lake are located on Big Bottom Creek, approximately 4 miles east of Bloomsdale, Missouri, in Ste. Genevieve County, as shown on the Regional Vicinity Map, Plate 1. The dam is located in the southern quarter of U.S. Survey 2046, approximately 2 miles southwest of the intersection of State Highway "O" and Interstate Highway 55.

c. Size Classification. The size classification, based on the height of the dam and storage capacity, is categorized as intermediate. (Per Table 1, Recommended Guidelines for Safety Inspection of Dams.)

d. Hazard Classification. The Lake Forest Dam, according to the St. Louis District, Corps of Engineers, has a high hazard potential, meaning that the dam is located such that a failure may cause loss of life, extensive agricultural damage or serious damage to homes, industrial and commercial facilities, important public utilities, main highways, or railroads. The estimated flood damage zone, should failure of the dam occur, has been determined by the St. Louis District to extend ten miles downstream of the dam. There are at least two homes and one bridge crossing within the first two miles downstream of the dam.

e. Ownership. The lake and dam are owned by Mr. Gerald Trautman, Route 2, Lake Forest, Ste. Genevieve, Missouri, 63670.

f. Purpose of Dam. The dam impounds water for the purpose of recreation by the property owners of Lake Forest Estates.

g. Design and Construction History. The Owner indicated that the dam was constructed in 1970 by the H. F. Gegg Construction Company, a local contractor experienced in construction of earthfill dams. Shortly after construction of the dam was completed and the lake filled, water was noticed flowing in the downstream channel. The Owner contacted the Missouri Geological Survey (MGS) and requested an investigation of the problem. The MGS concluded that seepage was occurring through bedding planes in the bedrock and recommended pressure grouting the underlying bedrock foundation strata. This work was performed in 1970 by the Jennings Drilling Company, a contractor located in Bonne Terre, Missouri.

h. Normal Operational Procedure. The lake level is unregulated.

1.3 PERTINENT DATA

a. Drainage Area. The area tributary to the lake, with the exception of the immediate area surrounding the lake which is in various stages of residential development, is for the most part undeveloped and in a natural state covered with timber. The watershed above the dam amounts to approximately 2,700 acres. The watershed area is outlined on Plate 1.

b. Discharge at Damsite.

(1) Estimated maximum flood at damsite ... 250± cfs(1)

(2) Spillway capacity ... 2,200 cfs

(1) Discharge value over spillway computed for water surface at elevation 509.0 based upon high lake level indicated by the Owner.

c. Elevation (ft. above MSL). The pavement elevation at the southwest corner of the concrete bridge over the spillway was used as a benchmark with an assumed elevation of 523.4. The basis of this assumption was the elevation (507) shown on the Weingarten N.S. Missouri Quadrangle Map, Advanced Edition, and this was considered to be the elevation of the lake at normal pool level.

(1) Top of dam ... 515.8 (min.)
(2) Normal pool (spillway crest) ... 507.0
(3) Streambed at centerline of dam ... 469.4±
(4) Maximum tailwater (Big Bottom Creek) ... Unknown
(5) Sewage treatment lagoons (water level) ... 469.0

d. Reservoir.

(1) Length of Normal pool (elevation 507.0) ... 5,500 ft.
(2) Length of maximum pool (elevation 515.8) ... 6,000 ft.

e. Storage.

(1) Normal pool ... 1,100 ac.ft.
(2) Top of dam (incremental) ... 900 ac.ft.

f. Reservoir Surface.

(1) Top of dam ... 115 acres
(2) Normal pool ... 87 acres

g. Dam.

(1) Type ... Earthfill, clay core (per Owner)
(2) Length ... 750 ft.
(3) Height ... 46 ft.
(4) Top width ... 38 ft.
(5) Side slopes
    a. Upstream ... 1v on 3h (upper), unknown (lower)(1)
    b. Downstream ... 1v on 2h
(6) Cutoff ... Core trench (per Owner)

(1) 20 ft. wide berm at elevation 507.0±.

(7) Slope protection

a. Upstream ... Grass with riprap slightly above at normal pool elevation

b. Downstream ... Grass

h. Spillway ... Rock cut, U-section, 32-foot bottom width.

i. Outlet for Lake Drawdown.

(1) Size ... 14-inch

(2) Type ... Steel pipe

(3) Location ... Near the center of the dam

(4) Control ... Gate, manual, on downstream end

(5) Invert elevation at outlet end ... 469.0

(6) Invert elevation at inlet end ... Unknown (submerged)

SECTION 2 - ENGINEERING DATA

2.1 DESIGN

No engineering data relating to the design of the dam are known to exist.

2.2 CONSTRUCTION

No formal records were kept during the construction of the dam. The Owner reported that a trench was excavated approximately 30 feet wide to bedrock along the alignment of the dam. The trench was backfilled with clay and the embankment constructed. Material used to backfill the trench and construct the earthfill dam was obtained from the area to be occupied by the lake. Shortly after construction of the dam was completed, water was noticed flowing in the downstream channel. At the request of the Owner, an inspection of the dam was made by Mr. E. E. Lutzen, a representative of the Missouri Geological Survey, to determine the nature of the observed leakage and to recommend a means of preventing further loss of water from the lake. Mr. Lutzen recommended (see Charts 2-1 and 2-2) that the underlying bedrock foundation strata at the dam be pressure grouted in order to seal the permeable formations in these locations. Subsequently, a grouting program, with grout holes at 5 feet on centers across the entire dam and extending to a depth of about 150 feet, was carried out. The grouting of the foundation strata at the dam reduced leakage from the lake to the point where it is, according to the Owner, no longer a problem. At the time of the inspection, no seepage through the embankment was noticed.

2.3 OPERATION

The lake level is governed by an uncontrolled, excavated rock spillway. It was reported by the Owner that the lake reached a level about 2 feet above normal pool level in the spring of 1977.

An 8-inch diameter sanitary sewer is installed through the embankment at approximately the center of the dam. The Owner reported that the sewer was constructed using "Truss" pipe. Truss pipe is an internally-braced double-wall pipe consisting of a hardened cement mixture between the internal and external plastic pipe walls. The trunk sewer was installed within the old stream channel, and laterals were placed as required by lot locations, to the edge of the lake. According to the pipe supplier, the pipe was placed in a trench and concrete collars installed around the pipe at all joint locations. During construction of the dam, the 8-inch pipe was broken near the upstream toe of slope. To make repairs, a 6-inch diameter steel pipe was then placed within the broken portion of the 8-inch pipe. It is not known how the 6-inch and 8-inch pipes were made integral. The sanitary sewer provides service for all homes within the Lake Forest Estates Development.

2.4 EVALUATION

a. Availability. Engineering data for assessing the design of the earthfill dam and spillway were unavailable.

b. Adequacy. No data available. Seepage and stability analyses comparable to the requirements of the "Recommended Guidelines for Safety Inspection of Dams" were not available, which is considered a deficiency. These seepage and stability analyses should be performed for appropriate loading conditions and made a matter of record.

SECTION 3 - VISUAL INSPECTION

3.1 FINDINGS

a. General. A visual inspection of the dam and spillway was made by Horner & Shifrin engineering personnel on 9 August 1978. Also inspected at this time were the area downstream from the dam, the various downstream road crossings, and the homes between the dam and the Mississippi River. Photographs of the dam and spillway taken at the time of the inspection are included on Pages A-1 thru A-4 of the Appendix.

b. Dam. The visible portions of the upstream and downstream slopes (see Photos 1 and 2) of the dam appeared to be in sound condition with the exception of some minor erosion of the downstream slope. A few small trees and a moderately dense cover of brush exist on the downstream slope. The brush completely covered the slope from the dam crest to the valley floor. Grass is growing on the upstream dam slope, and completely covers the slope from the dam crest to the normal pool elevation of the lake. The upstream slope has a twenty foot wide bench at approximately the normal pool elevation. A riprap blanket consisting of dumped limestone material exists on the upstream slope, beginning at an elevation slightly higher than the normal pool elevation. The limestone material ranges in size from small pieces weighing less than 5 pounds to large pieces weighing more than 200 pounds. The blanket extends well down the slope into the lake.

A gravel road traverses the dam crest and a concrete bridge has been installed over the spillway (see Photos 5 and 7). The elevation of the top of the dam, as determined by survey, was found to be approximately 5 feet lower at a location near the center of the dam than in the area adjacent to the spillway. A concrete boat launching ramp is located on the upstream slope near the spillway. The concrete bridge and ramp are in good condition.

A sewage treatment lagoon system (see Photo 3) is located immediately downstream of the dam. A manhole, assumed to be on the sanitary sewer pipe

passing under the dam, is located at the downstream toe of slope near the center of the dam. Due to the difficulty involved in removing the manhole cover, inspection was not made of the interior.

A 14-inch diameter steel pipe for dewatering the lake is located near the center of the dam. A valve for controlling the flow through this pipe is located on the downstream side of the dam (see Photo 4). A channel with cement stabilized side slopes has been installed at the outlet of the drawdown pipe. The purpose of the channel is to prevent erosion of the subgrade and to divert water flowing from the pipe away from the lagoon dike. The depth of the upstream end of the 14-inch pipe could not be determined at the time of the inspection.

c. Spillway. The spillway is cut into rock (see Photo 6) at the left abutment. The control elevation of the spillway is approximately nine feet lower than the low point of the dam. A profile of the dam crest centerline extending through the spillway is shown on Plate 3. A concrete bridge (see Photos 5 and 7) spans the spillway channel along the alignment of the dam. The spillway channel joins Big Bottom Creek approximately 450 feet downstream of the dam. A series of rock falls is located in the spillway channel just upstream of the junction with the original stream. A profile along the spillway channel centerline through the control section is shown on Plate 3.

d. Downstream Channel. The downstream channel is unimproved. The stream joins Establishment Creek approximately 2 miles downstream of the dam. Establishment Creek joins the Mississippi River approximately ten miles downstream of the dam.

3.2 EVALUATION

The deficiencies observed during this inspection are not considered of major consequence to warrant immediate remedial action. The brush and trees should be removed from the downstream slope and the slope re-examined to determine its condition. The removal work should be performed in a manner which will not disturb the existing turf cover.

SECTION 4 - OPERATIONAL PROCEDURES

4.1 PROCEDURES

The spillway is uncontrolled. The water surface level is governed by rainfall runoff, evaporation, seepage, and the capacity of the uncontrolled spillway.

4.2 MAINTENANCE OF DAM AND SPILLWAY

Based on the dense cover of vegetation on the downstream slope of the dam, it is apparent that this area receives a limited amount of attention. According to the Owner, the grass on the downstream slope is mowed infrequently. The upstream slope is mowed regularly throughout the growing season and trees are removed from the embankment approximately once a year.

4.3 MAINTENANCE OF OUTLET OPERATING FACILITIES

No outlet operating facilities exist at this dam.

4.4 DESCRIPTION OF ANY WARNING SYSTEMS IN EFFECT

The inspection did not reveal the existence of a dam warning system.

4.5 EVALUATION

Based on the substantial cover of grass on the downstream slope and the riprap protection on the upstream slope, as well as the general condition of the dam, it is evident that the dam is reasonably well maintained. It is recommended, however, that the trees present in the upstream slope be removed, that the grass on the downstream slope be cut more often, and that the vegetation present in the lake at the approach to the spillway be removed.

SECTION 5 - HYDRAULIC/HYDROLOGIC

5.1 EVALUATION OF FEATURES

a. Design Data. Design data are not available.

b. Experience Data. The drainage area and lake surface area were measured using an advanced USGS Weingarten N.W. Missouri Quadrangle Map. The proportions and dimensions of the spillway and dam were determined from surveys made during the inspection.

c. Visual Observations.

(1) The crest of the excavated rock spillway section is in good condition. Vegetation extending above the lake water surface elevation is located in the approach to the spillway.

(2) a 14-inch diameter pipe is used to dewater the lake.

(3) The spillway and outlet channel are located in the left abutment of the dam. Spillway releases, within the limited capacity of the spillway section, will not endanger the integrity of the dam.

(4) The top of the dam is approximately 5 feet lower near the center of the dam than the top of the dam near the spillway.

d. Overtopping Potential. The spillway section is too small to pass the probable maximum flood or the 1/2 probable maximum flood. The spillway section will pass the lake outflow resulting from the 1 percent chance (100-year frequency) flood without overtopping the dam. The results of a dam overtopping analysis are as follows:

Ratio of PMF	Q - Peak Outflow (cfs)	Max. Lake Water Surface Elev.	Max. Depth of Flow Over Dam (Elev. 515.8)	Duration of Overtopping of Dam (Hours)
0.22	2,190	515.8	0	0
0.5	12,850	519.6	3.8	5.0
1.0	28,700	522.0	6.2	7.5
100-Year Flood	1,870	514.9	0	0

The flow safely passing the spillway just prior to overtopping amounts to about 2,190 cfs, which is the outflow corresponding to about 22 percent of the probable maximum flood inflow. This flow rate is greater than the 1 percent chance (100-year frequency) flood.

Procedures and data for determining the probable maximum flood, the 100-year frequency flood, and the discharge rating curve for flow over the spillway and the dam crest are presented on Pages B-1 and B-2 of the Appendix. A listing of the HEC-1 (Dam Safety Version) input data is shown on Pages B-3 through B-6 of the Appendix. A copy of the computer output tables titled "Summary of Dam Safety Analysis" is presented on Page B-7.

SECTION 6 - STRUCTURAL STABILITY

6.1 EVALUATION OF STRUCTURAL STABILITY

a. Visual Observations. With the possible exception of the lagoons located near the toe of slope, there was no evidence of, nor conditions observed during the inspection, which adversely affect the structural stability of the dam.

b. Design and Construction Data. No design or construction data relating to the structural stability of the dam are known to exist.

c. Operating Records. No appurtenant structures or facilities requiring *operation exist at this dam.* According to the owner, no records have been kept of lake level, spillway discharge, dam settlement, or seepage.

d. Post Construction Changes. According to the Owner, the only post construction changes made to the dam consist of the pressure grouting of the pervious rock strata foundation beneath the dam.

e. Seismic Stability. Since the dam is located within a Zone II seismic probability area, an earthquake of the magnitude predicted is not expected to produce a hazardous condition to the dam, provided that static stability conditions are satisfactory and conventional safety margins exist.

SECTION 7 - ASSESSMENT/REMEDIAL MEASURES

7.1 DAM ASSESSMENT

a. Safety. A hydraulic analysis indicated the excavated rock spillway to be capable of passing lake outflow of about 2,190 cfs without the level of the lake exceeding the low point in the top of the dam. A hydrologic analysis of the runoff from the lake watershed area, as discussed in Section 5, indicated that for a storm runoff of maximum probable flood magnitude, the lake outflow would be on the order of 28,700 cfs, which would result in a 6.2-foot maximum depth of flow over the crest of the dam at its low point. For the 1 percent chance (100-year frequency) flood, the lake outflow would be about 1,870 cfs.

A condition noticed during the visual inspection that could affect the safety of the dam is the lagoons located in the area adjacent to the downstream toe of slope. The possibility exists that the presence of these lagoons may affect the structural stability of the dam in the vicinity of the lagoons since the mass of earth resisting movement of the embankment is reduced. Investigations made during the inspection did not disclose that stability and seepage analyses of the dam had been performed.

b. Adequacy of Information. Due to the lack of engineering and construction data, the assessments reported herein were based on external conditions as determined during the visual inspection. Those recommendations with regard to the hydrology of the lake and the capacity of the spillway were based on a hydrologic/hydraulic study as indicated in Section 5. Seepage and stability analyses comparable to the requirements of the "Recommended Guidelines for Safety Inspection of Dams" were not available, which is considered a deficiency.

c. Urgency. The safety defects noted in paragraph 7.1a regarding the limited capacity of the spillway section should be investigated without delay since failure of the dam may result from overtopping. The remaining items

concerning the safety of the dam and the remedial measures recommended in paragraph 7.2 should be accomplished in the near future.

d. Necessity for Phase II. Based on the results of the Phase I inspection, a Phase II investigation is not recommended.

e. Seismic Stability. Since the dam is located within a Zone II seismic probability area, an earthquake of the magnitude predicted is not expected to produce a hazardous condition to the dam, provided that static stability conditions are satisfactory and conventional safety margins exist.

7.2 REMEDIAL MEASURES

a. Recommendations. The following actions are recommended:

(1) Based upon criteria set forth in the recommended guidelines, alterations should be made to the design of the dam in order to pass lake outflow resulting from a storm of at least probable maximum flood magnitude.

(2) Obtain the necessary soil data and perform stability and seepage analyses in order to determine the structural stability of the dam for all operational conditions. The presence of the sewage lagoons in the area adjacent to the downstream toe of slope should be included in the evaluation of the dam stability. Seepage and stability analyses should be performed by a professional engineer experienced in the design and construction of dams.

b. Operations and Mainteance (O & M) Procedures. The following O & M procedures are recommended:

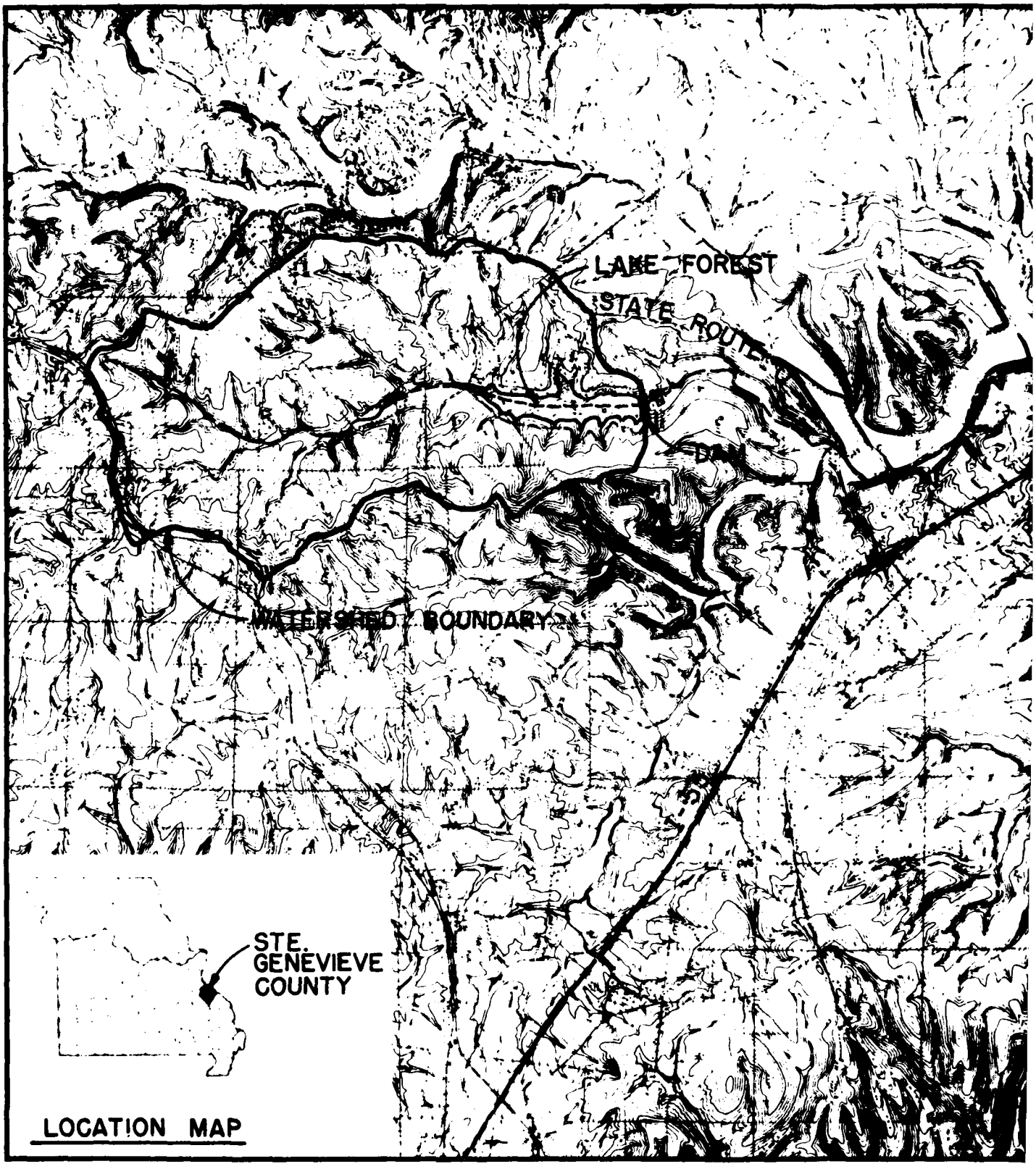
(1) Remove the trees and brush from the downstream slope of the dam. Tree roots may provide a passageway for seepage and can lead to a piping

condition and potential failure. The existing ground surface and turf cover should be restored if destroyed or missing. Maintain the turf cover on the slope at a height that will not hinder inspection of the slopes and which will not provide cover for burrowing animals.

(2) Remove the vegetation present in the lake at the approach to the spillway in order to allow flow to enter the spillway unrestricted.

(3) The control valve located at the outlet end of the drawdown pipe should be tested for proper operation to insure the valve's usefulness.

(4) Detailed inspections of the dam should be instituted on a regular basis by an engineer experienced in the design and construction of dams. It is also recommended, for future reference, that records be kept of all inspections made and remedial measures taken.


LAKE FOREST
STATE ROUTE
WATERSHED BOUNDARY
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GENEVIEVE
COUNTY
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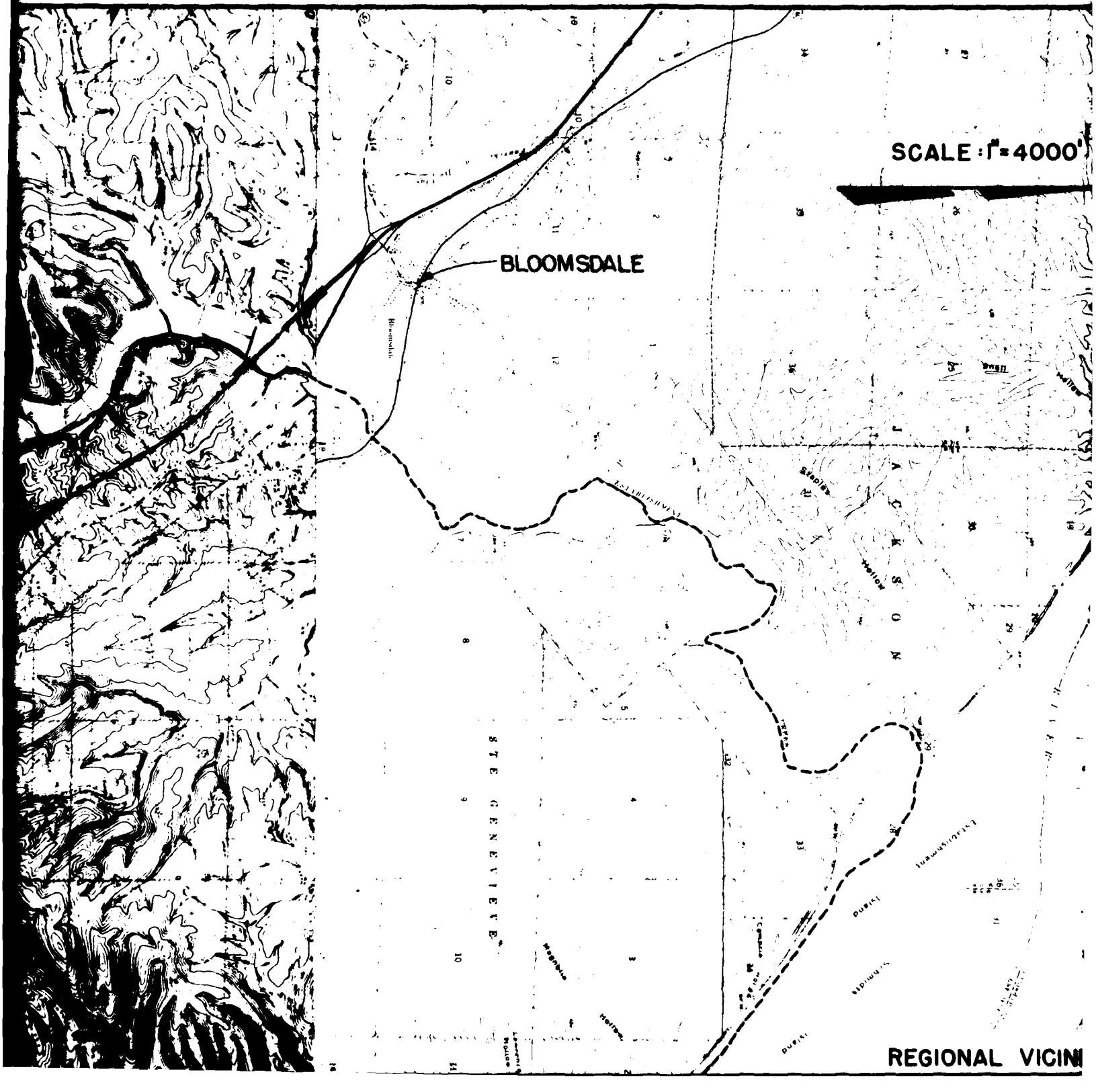
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BLOOMSDALE
REGIONAL VICINI

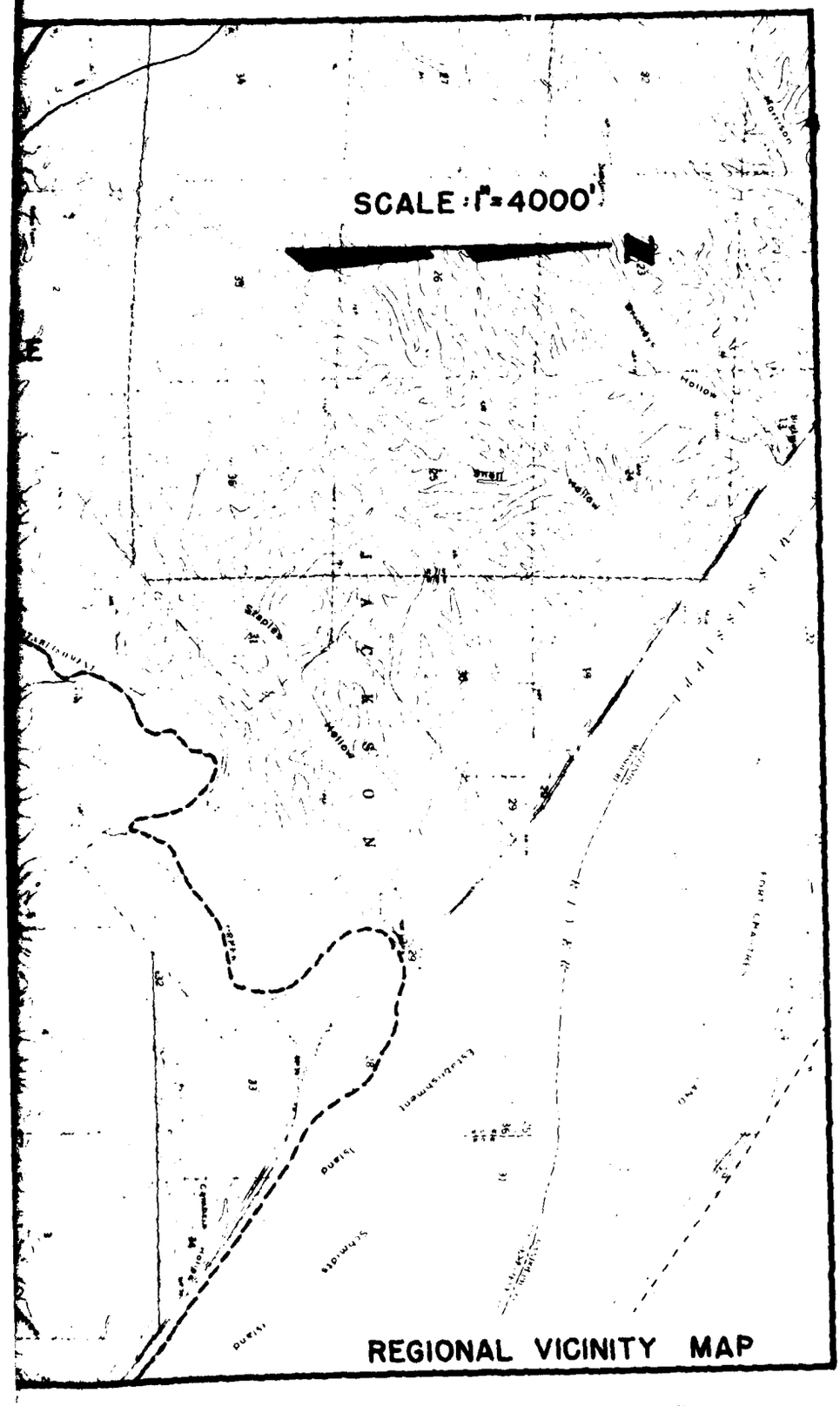
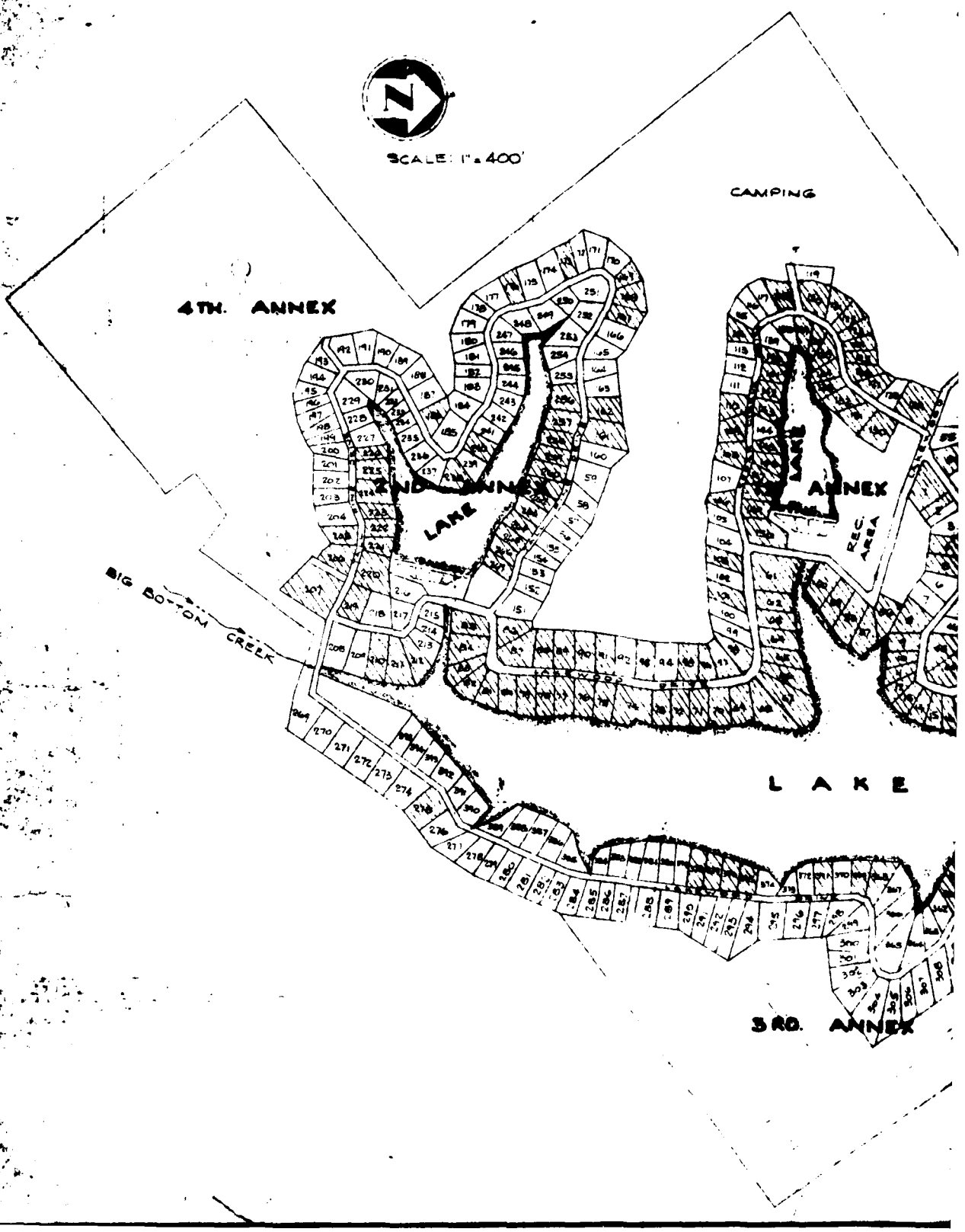


PLATE 1

KE FOREST ESTATES

STE. GENEVIEVE COUNTY, MISSOURI



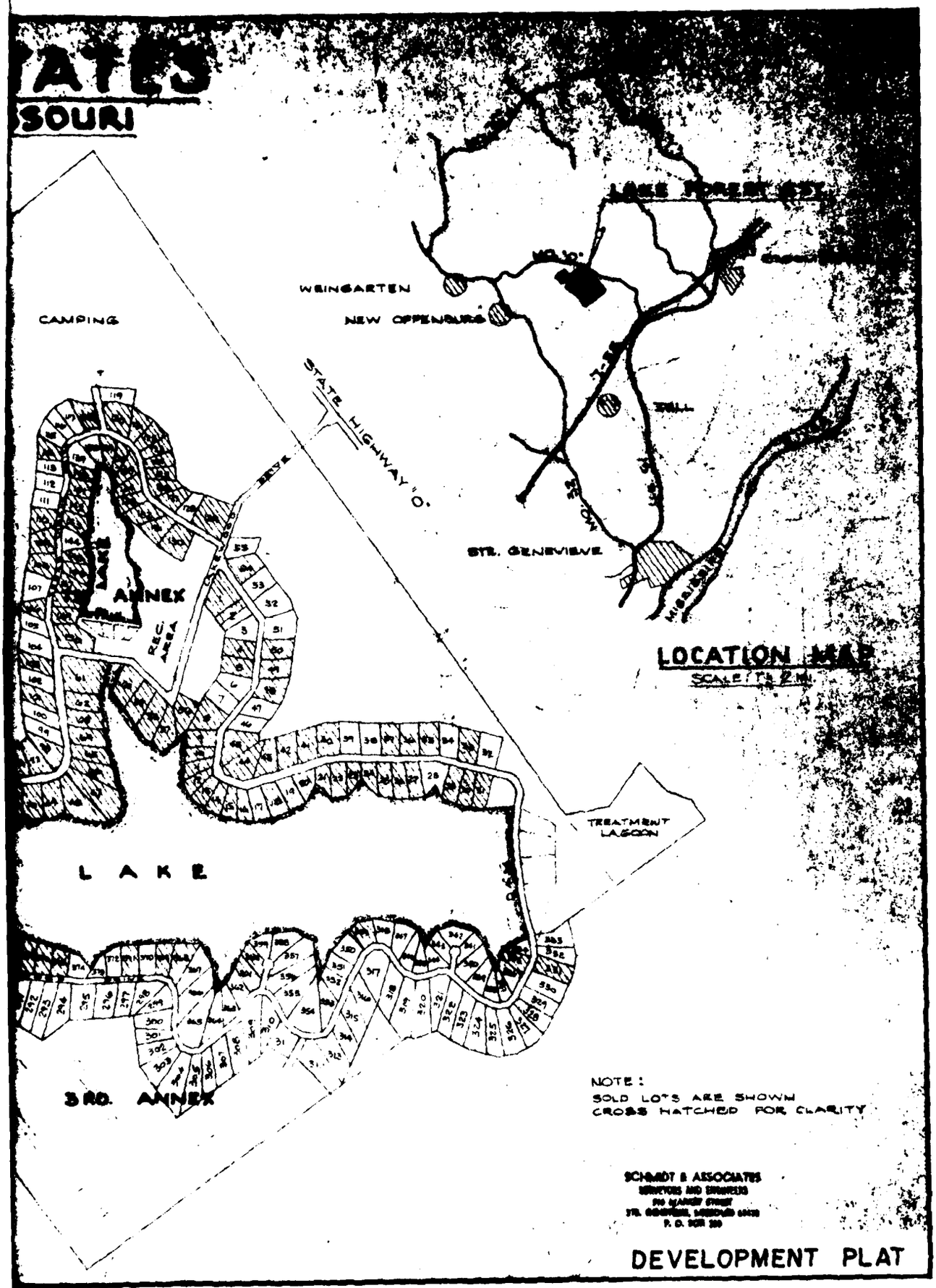
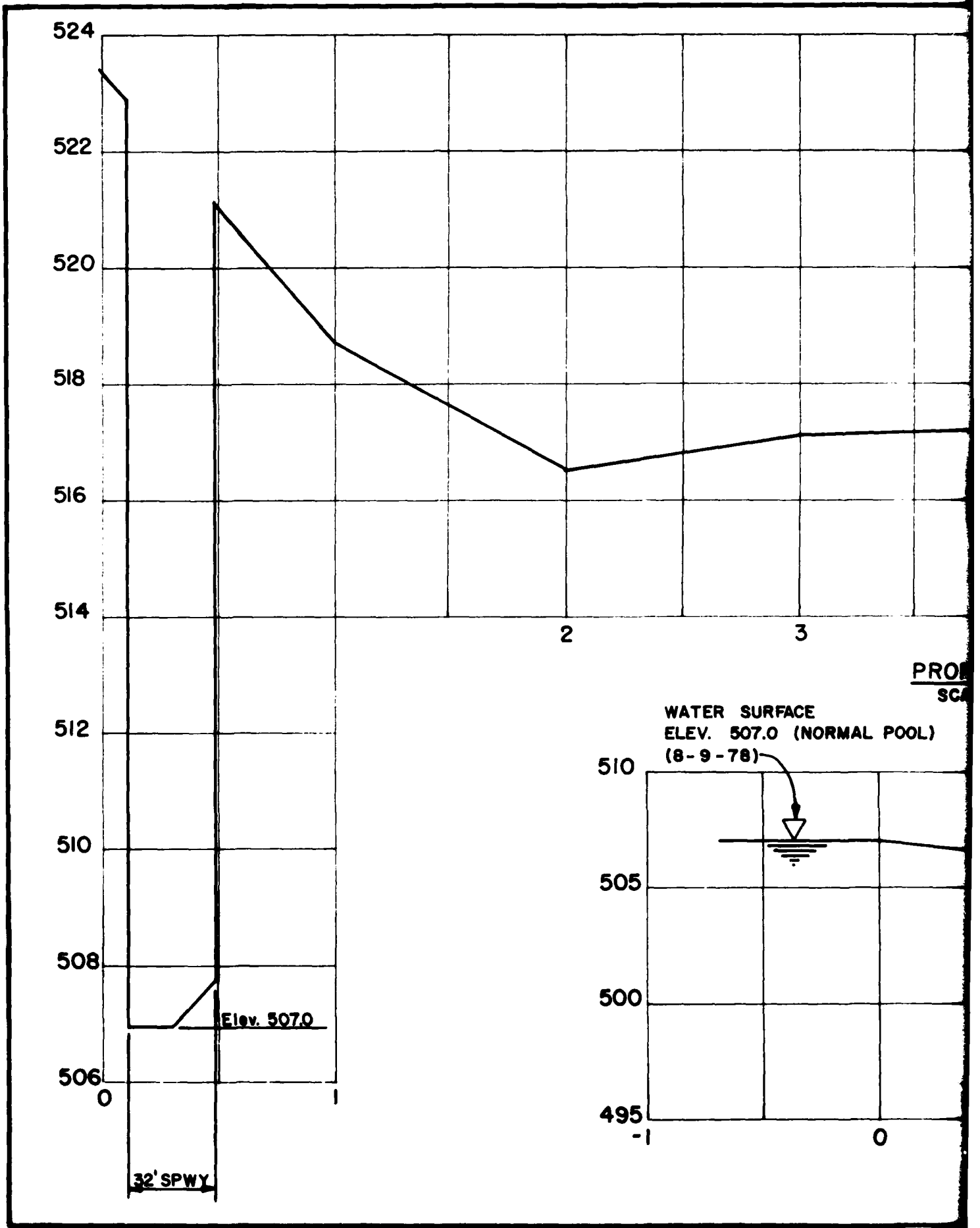
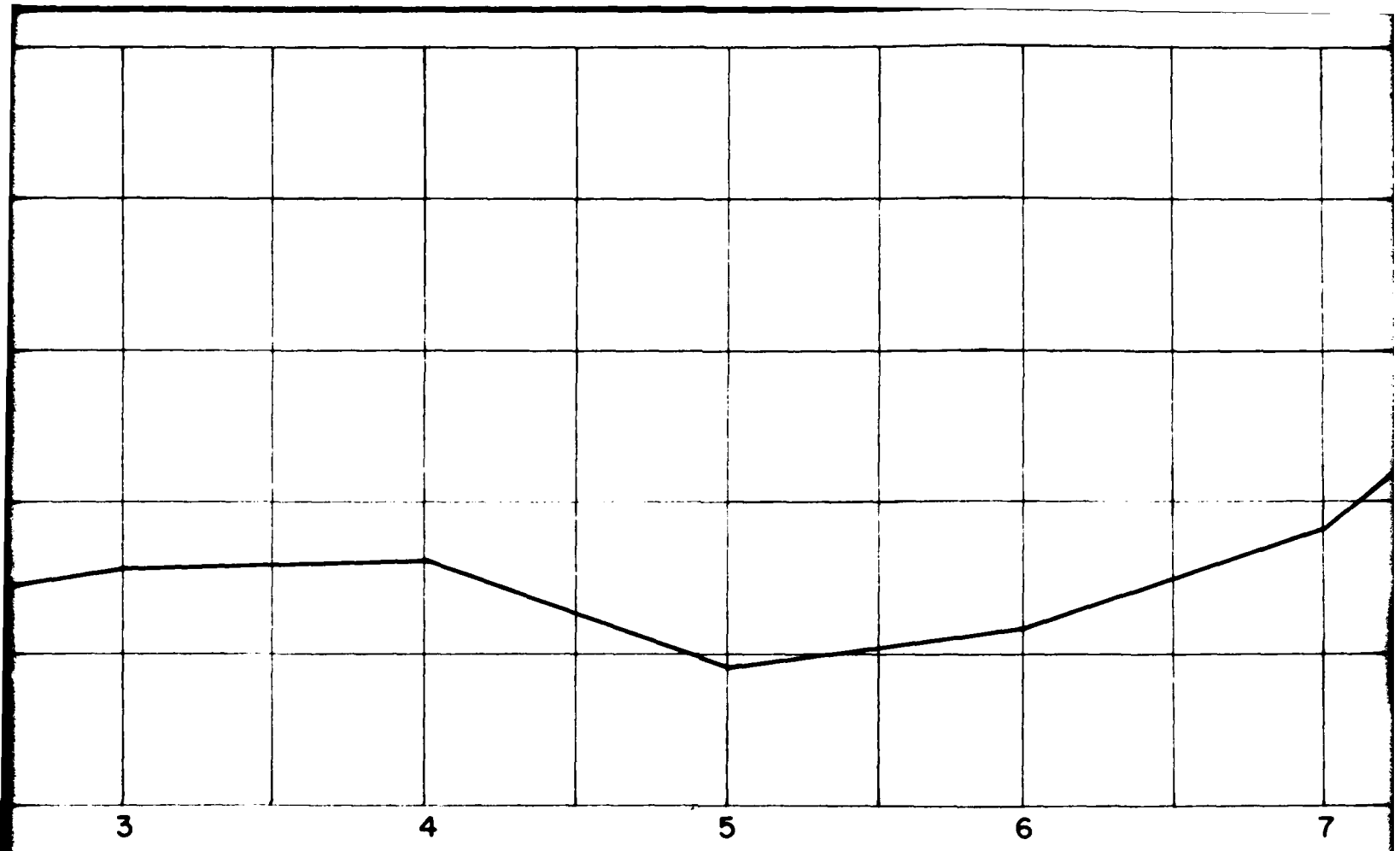
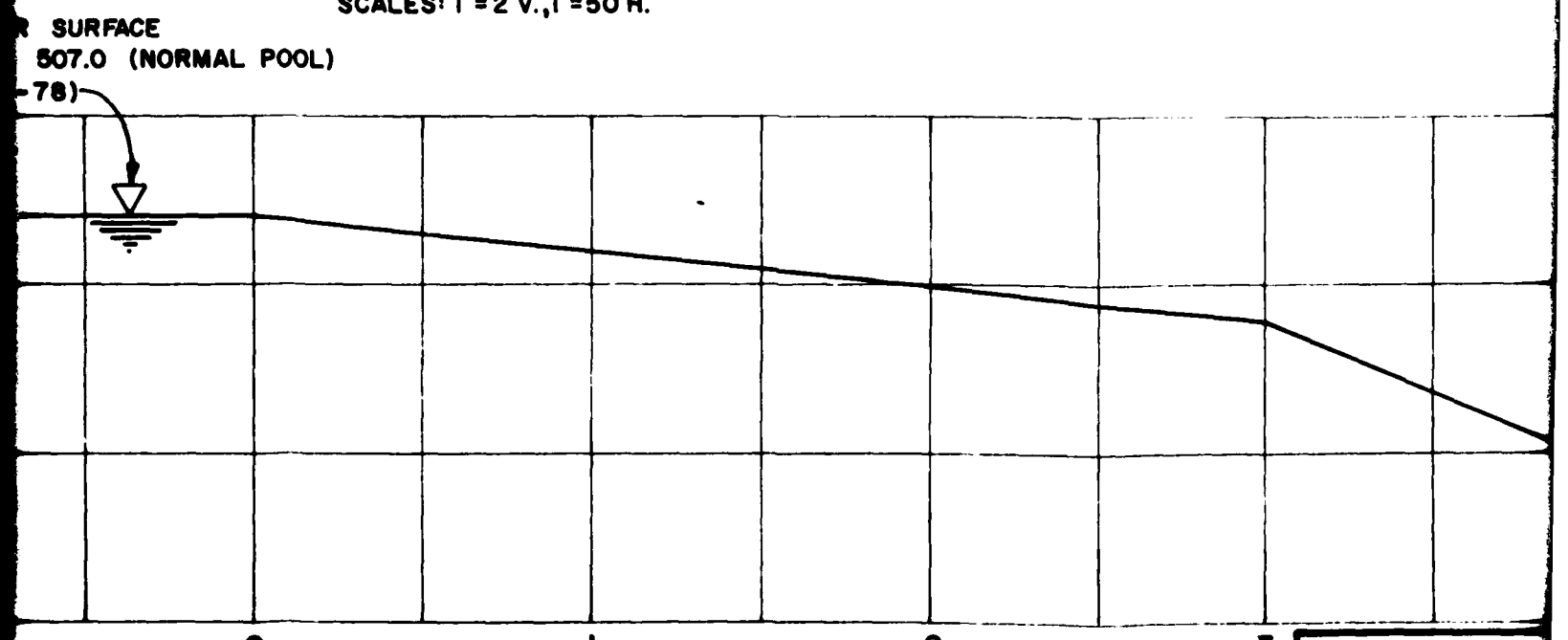

WEINGARTEN
NEW OFFENBURG
CAMPING
STATE HIGHWAY "O"
STE. GENEVIEVE
ANNEX
REC. AREA
TREATMENT LAGOON
LAKE
3RD. ANNEX
LOCATION MAP
SCALE: 1" = 2 MI.
NOTE:
SOLD LOTS ARE SHOWN
CROSS HATCHED FOR CLARITY
SCHMIDT & ASSOCIATES
DEVELOPMENT PLAT

PLATE 2


524
522
520
518
516
514
512
510
508
506
0
1
2
3
Elev. 507.0
32' SPWY
PROF
SC
WATER SURFACE
ELEV. 507.0 (NORMAL POOL)
(8-9-78)
510
505
500
495
-1
0

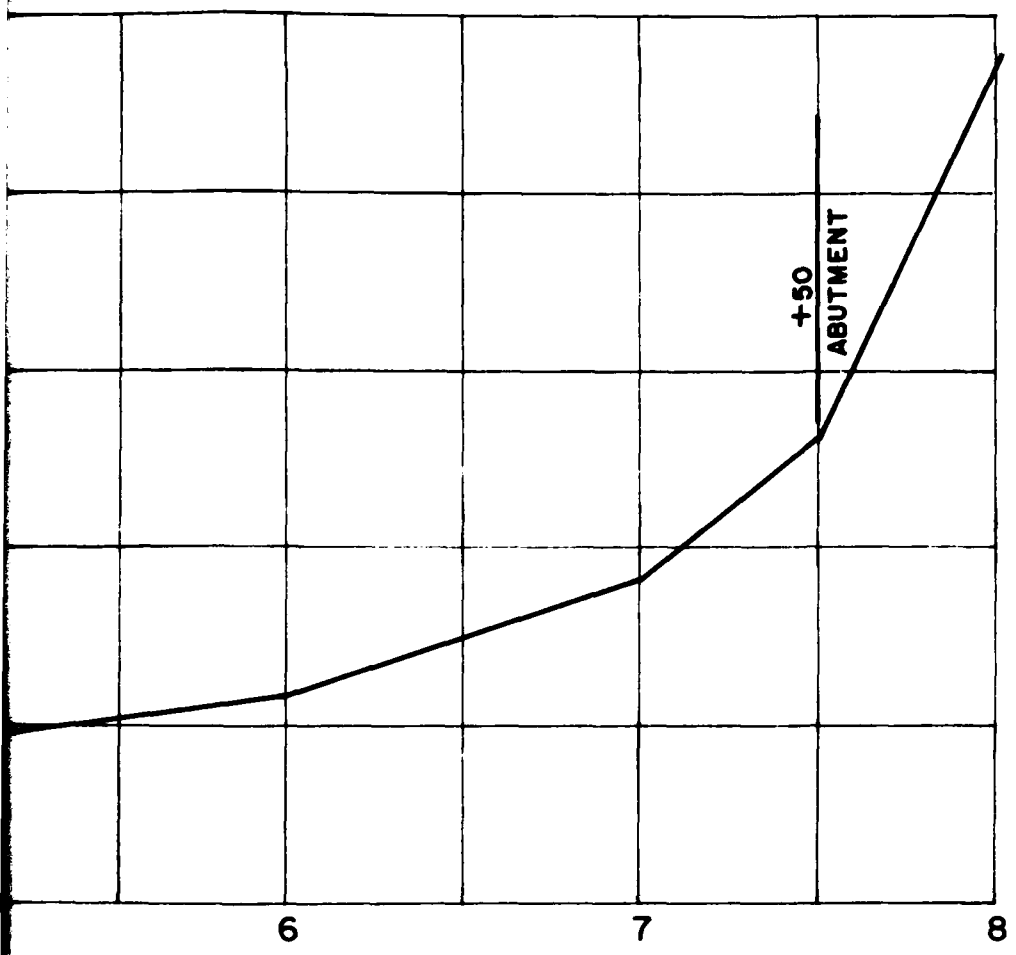


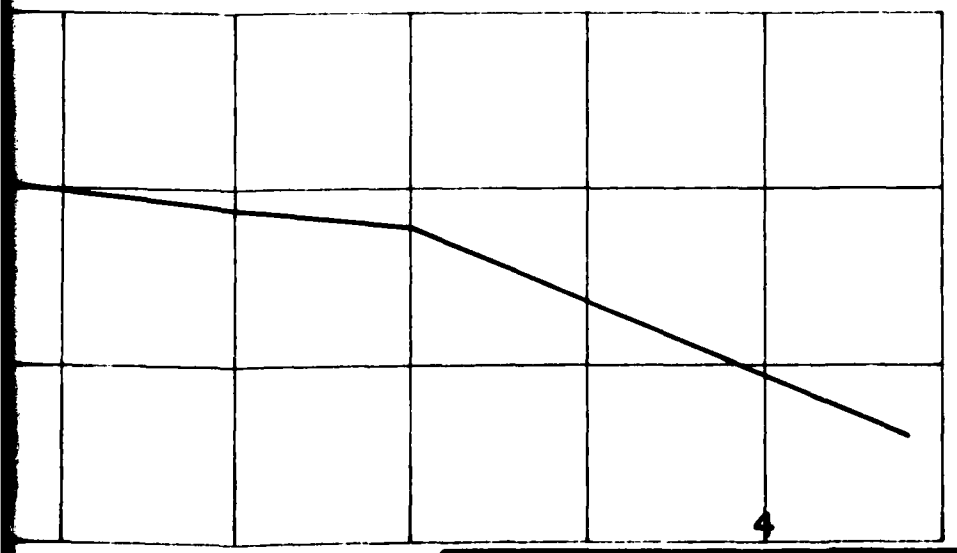
PROFILE DAM CREST
SCALES: 1"=2' V., 1"=50' H.



PROFILE SPILLWAY ℄
SCALES: 1"=5' V., 1"=50' H.

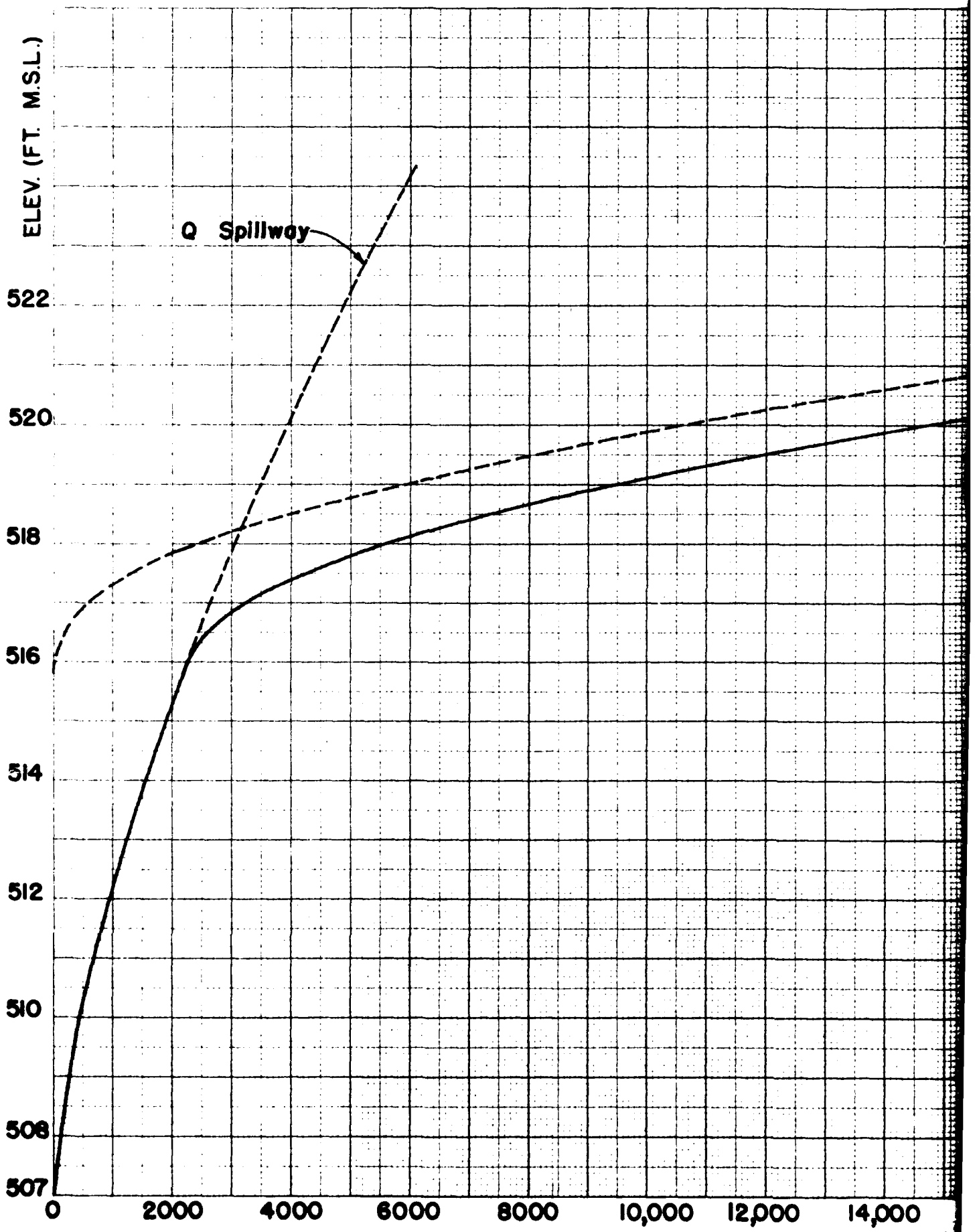
LAKE
DAM & SPILL
Horner & Shifr

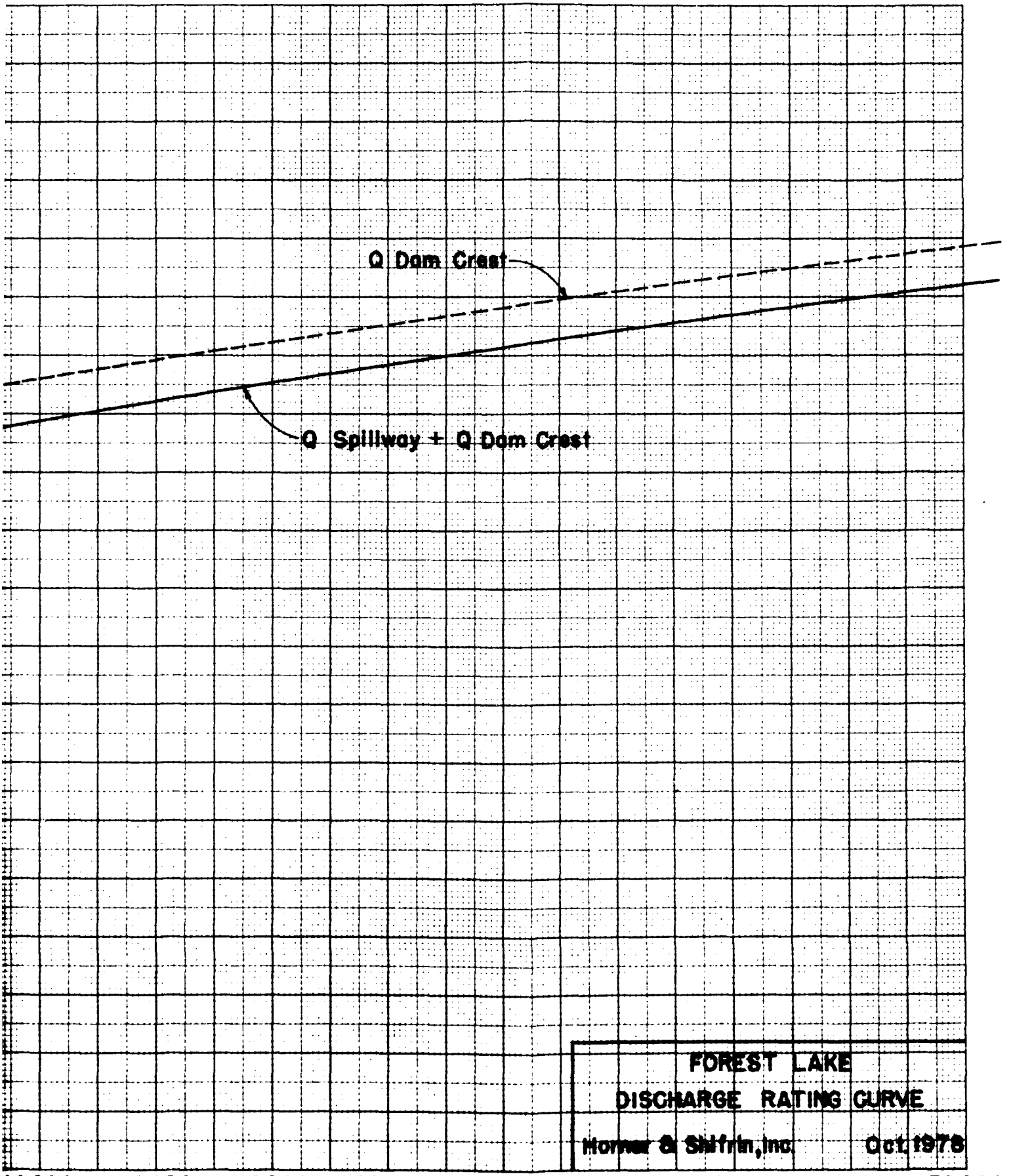




WAY ℄
1"=50'H.

LAKE FOREST
DAM & SPILLWAY PROFILES
Horner & Shifrin, Inc. Oct. 1978


ELEV. (FT. M.S.L.)
Q Spillway
522
520
518
516
514
512
510
508
507
0
2000
4000
6000
8000
10,000
12,000
14,000



FOREST LAKE
DISCHARGE RATING CURVE
Horner & Shifrin, Inc. Oct. 1978

PLATE 4

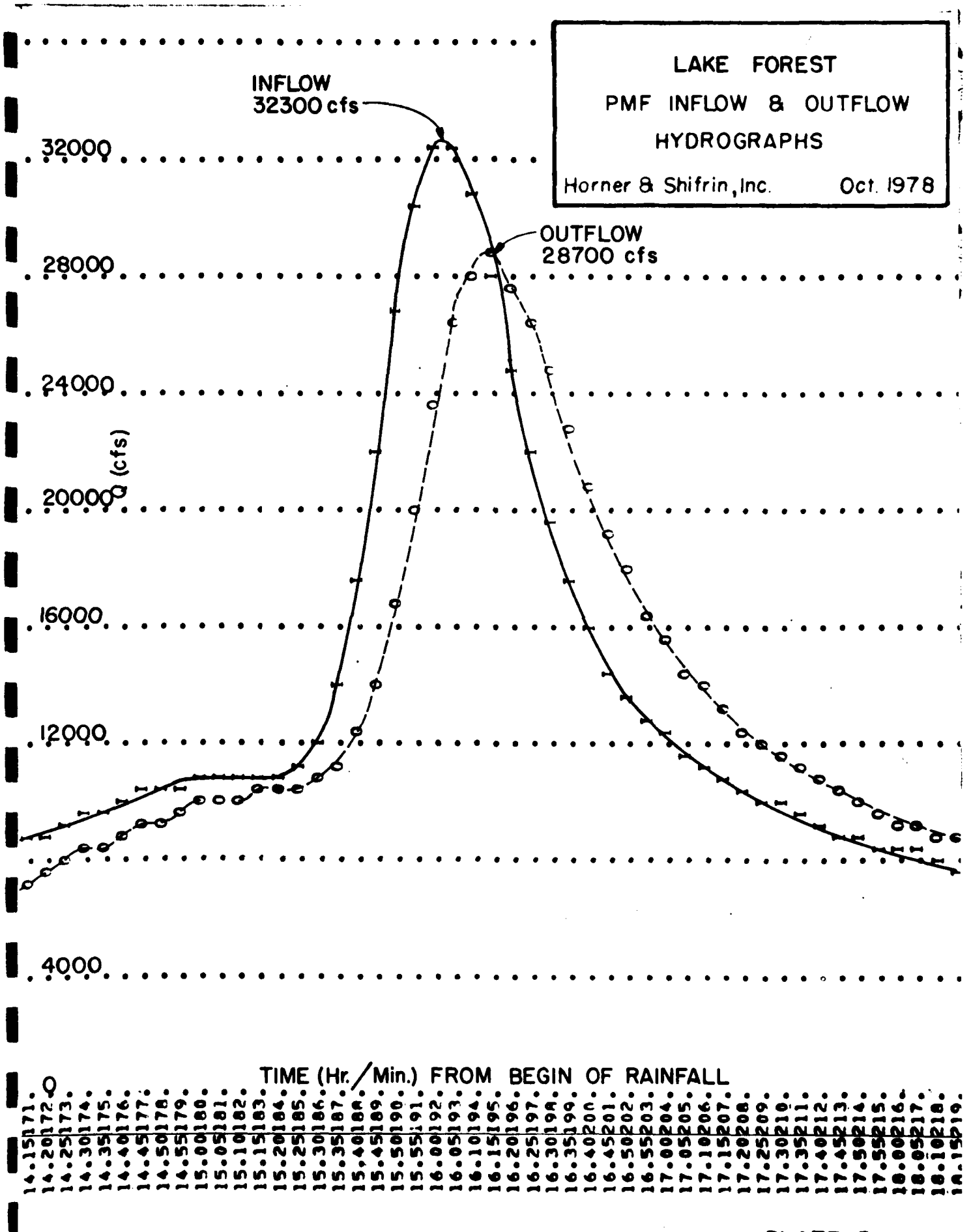

LAKE FOREST
PMF INFLOW & OUTFLOW
HYDROGRAPHS
Horner & Shifrin, Inc. Oct. 1978
INFLOW
32300 cfs
OUTFLOW
28700 cfs
32000
28000
24000
20000
16000
12000
4000
Q (cfs)
TIME (Hr./Min.) FROM BEGIN OF RAINFALL
Q
14.15171.
14.20172.
14.25173.
14.30174.
14.35175.
14.40176.
14.45177.
14.50178.
14.55179.
15.00180.
15.05181.
15.10182.
15.15183.
15.20184.
15.25185.
15.30186.
15.35187.
15.40188.
15.45189.
15.50190.
15.55191.
16.00192.
16.05193.
16.10194.
16.15195.
16.20196.
16.25197.
16.30198.
16.35199.
16.40200.
16.45201.
16.50202.
16.55203.
17.00204.
17.05205.
17.10206.
17.15207.
17.20208.
17.25209.
17.30210.
17.35211.
17.40212.
17.45213.
17.50214.
17.55215.
18.00216.
18.05217.
18.10218.
18.15219.

PLATE 5

For File only

on B3

ENGINEERING GEOLOGIC REPORT OF THE LAKE FOREST DAM SITE, STE. GENEVIEVE COUNTY
LOCATION: NW¼ SE¼ sec. 31 Projected. T. 37N., R. 7E., Weingarten Quadrangle

The above site was visited at the request of the developer to determine the possible source of leakage and water loss above the dam. An examination revealed that a large portion of the silt and clay soil had been removed near the dam site to construct the dam. This removal of the soil exposed alternating beds of dolomite and massive bedded sandstones that showed some solution work. The sandstones pinch out and the more extensive beds could be traced in the outcrop area only a 100 yards or so. The dolomite is a thin, flaggy to medium bedded dolomite. Solution enlarged crevasses are exposed in the outcrop areas. Examination of well drilling records for this area indicates this site is in the Cotter formation.

The soils in the floodplain consist of silt and clay possibly 5 to 10 feet thick overlying 15 or 20 feet of coarse granular materials. No surface flow exists at times, but backhoe excavation reveals that there is some water in the granular soils below the fine grained material. It was thought the first loss of water from the surface was into these dry gravels. However, subsequent testing of the formation indicate that water loss was through some bedding planes in the bedrock. Examination of well logs and borings taken by Union Electric for a proposed dam at this area some years ago, revealed that on the ridge to the northwest of the site caves have been found.

A drilling program was initiated by the owner starting on the left abutment and progressing on 5-foot centers across the dam. Drilling, coring and pressure grouting the foundation will be completed in hopes to seal off the water passages.

At the time of my last visit, about July 1, 1970, it was noticed that one small spring flowing downstream from the dam had ceased to flow immediately

after grouting was completed in that area. Small cavities and caves have been encountered within the drilling operation and if the grouting curtain is continued on in the manner in which it was started, from abutment to abutment, the remedial work may be a success and insure an overall success of the entire project.

E E Lutzen

Edwin E. Lutzen

July 20, 1970

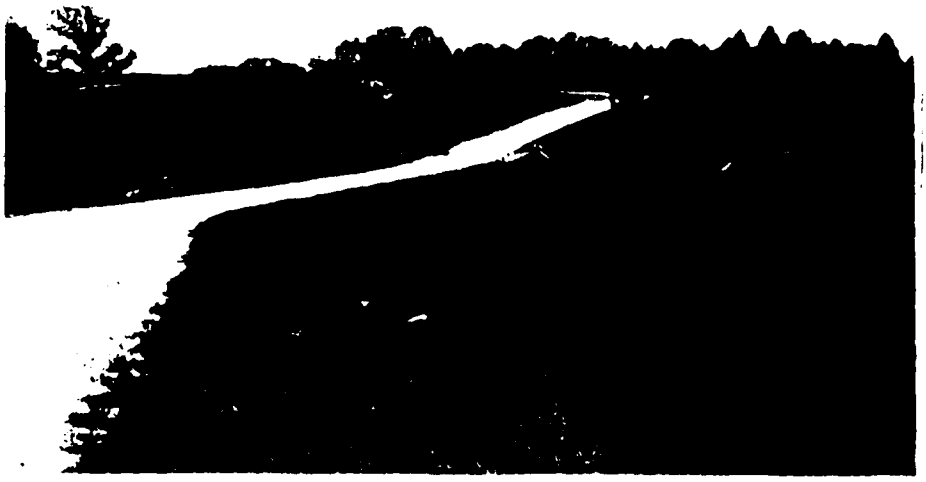
APPENDIX

NO. 1: UPSTREAM FACE OF DAM

NO. 2: DOWNSTREAM FACE OF DAM

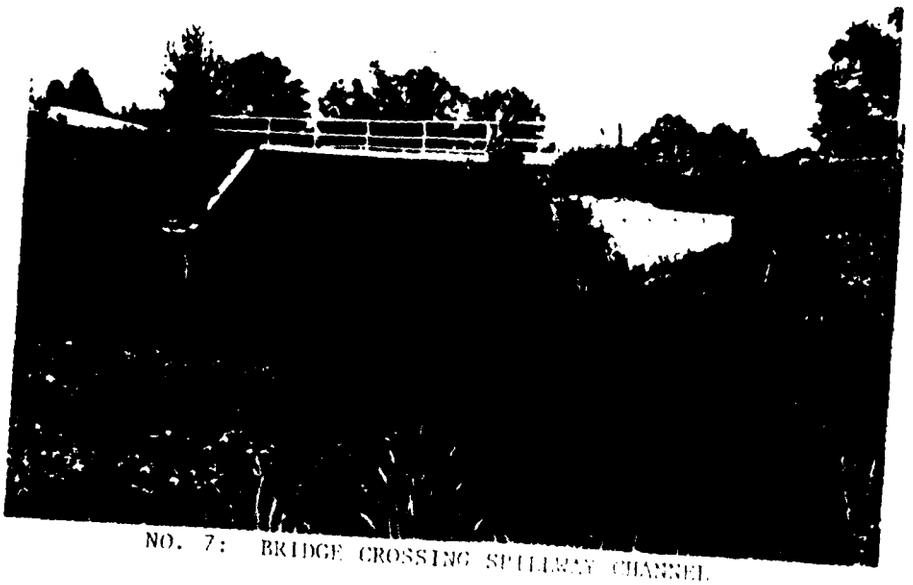
NO. 3: SEWAGE TREATMENT LAGOONS

NO. 4: 14" DRAWDOWN PIPE AND OUTLET CHANNEL

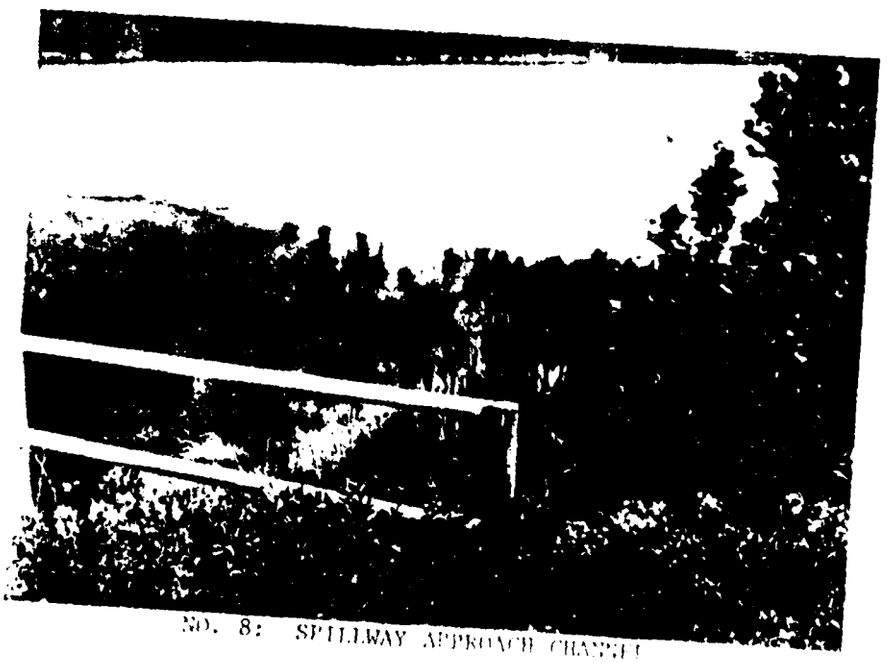


NO. 5: DAM CREST AND SPILLWAY BRIDGE

NO. 6: SPILLWAY CHANNEL



NO. 7: BRIDGE CROSSING SPILLWAY CHANNEL



NO. 8: SPILLWAY APPROACH CHANNEL

HYDROLOGIC COMPUTATIONS

1. The HEC-1 Dam Safety Version (July 1978) program was used to develop inflow and outflow hydrographs and dam overtopping analyses, with hydrologic inputs as follows:

a. Probable maximum precipitation (200 sq. mile, 24-hour value equals 26.1 inches) from Hydrometeorological Report No. 33. One hundred year frequency (10 square mile precipitation, 24-hour value equals 7.11 inches) from U.S. Weather Bureau Technical Paper No. 40.

b. Drainage area = 4.26 square miles
= 2,726 acres

c. SCS parameters
Lag time = 0.49 hours
Soil type CN = 91

2. The spillway section consists of a broad-crested, approximately "U" shaped rock section. Spillway release rates were based on the following equation:

$Q = CLH^{1.5}$ (C = 2.63, L = 32 feet) where H is the head on the weir.

3. The profile of the dam crest is irregular and flow over the dam crest cannot be determined by conventional weir formulas. Flow quantities overtopping the dam crest were determined as follows:

(1) Dam crest section properties (area, a and top width, t) were computed for various depths, d.

(2) It was assumed that flow leaving the crest would occur at critical depth. Flow at critical depth (Q_c) was computed as $Q_c = (\frac{a^3}{t}\ g)^{0.5}$ for the various depth, d.

Corresponding velocities (v_c) and velocity heads (H_{vc}) were determined using conventional formulas.

(3) Static lake levels corresponding to the various Q_c values passing over the dam crest were computed as critical depths plus critical velocity head ($d_c + H_{vc}$), and the relationship betweek lake level and crest discharge was thus obtained. The procedure neglects the minor insignificant friction losses across the length of the spillway.

4. Corresponding flows over the spillway and dam for given elevations were added to obtain the combined outflow rating curve for the dam and spillway. This rating curve is shown on Plate 4. Inflow and outflow hydrographs for the PMF are presented on Plate 5.

```
**********
FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION      JULY 1978
  LAST MODIFICATION  3 AUG 78
**********
    1                 A1       ANALYSIS OF DAM OVERTOPPING USING RATIOS OF PMF
    2                 A2       HYDROLOGIC-HYDRAULIC ANALYSIS OF SAFETY OF LAKE FOREST DAM
    3                 A3       RATIOS OF PMF ROUTED THROUGH RESERVOIR
    4                 B     288        0        5       -0       -0       -0       -0       -0       -0       -0
    5                 B1      5
    6                 J       1        8        1
    7                 J1    0.1     0.15     0.20     0.25     0.30     0.40     0.50     1.00
    8                 K       0  INFLOW                                 3        1
    9                 K1       INFLOW HYDROGRAPH
   10                 M       1        2     4.26                      1.0                        1
   11                 P       0     26.1      102      120      130
   12                 T                                                          -1      -91
   13                 W2              0.49
   14                 X    -1.0     -.10      2.0
   15                 K       1      DAM                          2        3        1
   16                 K1       RESERVOIR ROUTING BY MODIFIED PULS
   17                 Y                                      1        1
   18                 Y1      1                                                1093       -1
   19                 Y4    507      508      509      510      511      512      513      514      515    515.8
   20                 Y4  516.5      517    517.5      518    518.5      519      520      521      522      523
   21                 Y5      0       80      240      440      670      940     1240     1560     1900     2200
   22                 Y5   2580     3180     4130     5530     7280     9440    14650    20700    28040    36040
   23                 $A      0     87.2    129.5    224.1
   24                 $E  469.4      507      520      540
   25                 $$    507
   26                 $D  515.8
   27                 K      99
```

```
**********
FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION      JULY 1978
  LAST MODIFICATION  3 AUG 78
**********
    1                 A1       ANALYSIS OF DAM OVERTOPPING USING RATIOS OF PMF
    2                 A2       HYDROLOGIC-HYDRAULIC ANALYSIS OF SAFETY OF LAKE FOREST DAM
    3                 A3       RATIOS OF PMF ROUTED THROUGH RESERVOIR
    4                 B    2AA        0        5       -0       -0       -0       -0       -0       -0       -0
    5                 B1     5
    6                 J      1        1        1
    7                 J1  0.22
    8                 K      0  INFLOW                                    3        1
    9                 K1       INFLOW HYDROGRAPH
   10                 M      1        2     4.26                         1.0                         1
   11                 P      0     26.1      102      120      130
   12                 T                                                           -1      -91
   13                 W2            0.49
   14                 X   -1.0     -.10      2.0
   15                 K      1      DAM                          2        3        1
   16                 K1       RESERVOIR ROUTING BY MODIFIED PULS
   17                 Y                                    1        1
   18                 Y1     1                                                  1093       -1
   19                 Y4   507      508      509      510      511      512      513      514      515    515.8
   20                 Y4 516.5      517    517.5      518    518.5      519      520      521      522      523
   21                 Y5     0       80      240      440      670      940     1240     1560     1900     2200
   22                 Y5  2580     3180     4130     5530     7280     9440    14650    20700    28040    36040
   23                 SA     0     87.2    129.5    224.1
   24                 SE 469.4      507      520      540
   25                 SS   507
   26                 SD 515.8
   27                 K     99
```

```
**********
FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION      JULY 1978
  LAST MODIFICATION  3 AUG 78
**********
    1                A1       ANALYSIS OF DAM OVERTOPPING USING 100 YR FLOOD
    2                A2       HYDROLOGIC-HYDRAULIC ANALYSIS OF SAFETY OF LAKE FOREST DAM
    3                A3       100 YR FLOOD ROUTED THROUGH RESERVOIR
    4                B     2AA        0        5       -0       -0       -0       -0       -0       -0       -0
    5                B1      5
    6                J       1        1        1
    7                J1    1.0
    8                K       0  INFLOW                                    3        1
    9                K1       INFLOW HYDROGRAPH
   10                M       0        2     4.26                         1.0                         1
   11                O     288
   12                O1   .007     .007     .007     .007     .007     .007     .007     .007     .007     .007
   13                O1   .007     .007     .007     .007     .007     .007     .007     .007     .007     .007
   14                O1   .007     .007     .007     .007     .007     .007     .007     .007     .007     .007
   15                O1   .007     .007     .007     .007     .007     .007     .007     .007     .007     .007
   16                O1   .007     .007     .007     .007     .007     .007     .007     .007     .007     .007
   17                O1   .007     .007     .007     .007     .007     .007     .007     .007     .007     .007
   18                O1   .007     .007     .007     .007     .007     .007     .007     .007     .007     .007
   19                O1   .007     .007     .014     .014     .014     .014     .014     .014     .014     .014
   20                O1   .014     .014     .014     .014     .014     .014     .014     .014     .014     .014
   21                O1   .014     .014     .014     .014     .014     .014     .014     .014     .014     .014
   22                O1   .014     .014     .014     .014     .014     .014     .014     .014     .022     .022
   23                O1   .022     .022     .022     .022     .022     .022     .022     .022     .023     .023
   24                O1   .023     .023     .023     .023     .023     .023     .032     .032     .032     .032
   25                O1   .032     .032     .063     .063     .063     .064     .064     .065     .135     .138
   26                O1   .140     .232     .232     .507     .759     .353     .232     .142     .139     .136
   27                O1   .065     .064     .064     .064     .063     .063     .033     .032     .032     .032
   28                O1   .032     .032     .023     .023     .023     .023     .023     .023     .023     .023
   29                O1   .023     .022     .022     .022     .022     .022     .022     .022     .022     .022
   30                O1   .014     .014     .014     .014     .014     .014     .014     .014     .014     .014
   31                O1   .014     .014     .014     .014     .014     .014     .014     .014     .014     .014
   32                O1   .014     .014     .014     .014     .014     .014     .014     .014     .014     .014
   33                O1   .014     .014     .014     .014     .014     .014     .007     .007     .007     .007
   34                O1   .007     .007     .007     .007     .007     .007     .007     .007     .007     .007
   35                O1   .007     .007     .007     .007     .007     .007     .007     .007     .007     .007
   36                O1   .007     .007     .007     .007     .007     .007     .007     .007     .007     .007
   37                O1   .007     .007     .007     .007     .007     .007     .007     .007     .007     .007
   38                O1   .007     .007     .007     .007     .007     .007     .007     .007     .007     .007
   39                O1   .007     .007     .007     .007     .007     .007     .007     .007     .007     .007
   40                O1   .007     .007     .007     .007     .007     .007     .007     .007
   41                Y                                                                  -1       -01
```

```
41      T                                                          -1     -91
42      W2          0.49
43      X   -1.0    -.10    2.0
44      K      1     DAM                             2       3       1
45      K1      RESERVOIR ROUTING BY MODIFIED PULS
46      Y                                    1       1
47      Y1     1                                             1093      -1
48      Y4   507     508     509     510     511     512     513     514     515   515.8
49      Y4 516.5     517   517.5     518   518.5     519     520     521     522     523
50      Y5     0      80     240     440     670     940    1240    1560    1900    2200

51      Y5  2580    3180    4130    5530    7280    9440   14650   20700   28040   36040
52      $A     0    87.2   129.5   224.1
53      $E 469.4     507     520     540
54      $S   507
55      $D 515.8
56      K     99
```

SUMMARY OF DAM SAFETY ANALYSIS

PLAN 1 .....

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	507.00	507.00	515.80
STORAGE	1093.	1093.	1979.
OUTFLOW	0.	0.	2200.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
.10	511.71	0.00	1537.	861.	0.00	17.92	0.00
.15	513.51	0.00	1725.	1404.	0.00	17.58	0.00
.20	515.16	0.00	1907.	1960.	0.00	17.50	0.00
.25	516.60	.80	2073.	2702.	2.50	17.25	0.00
.30	517.55	1.75	2186.	4267.	3.25	16.75	0.00
.40	518.82	3.02	2342.	8666.	4.08	16.42	0.00
.50	519.65	3.85	2448.	12852.	5.00	16.33	0.00
1.00	522.05	6.25	2766.	28722.	7.50	16.25	0.00

SUMMARY OF DAM SAFETY ANALYSIS

PLAN 1 .....

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	507.00	507.00	515.80
STORAGE	1093.	1093.	1979.
OUTFLOW	0.	0.	2200.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
.22	515.78	0.00	1977.	2193.	0.00	17.50	0.00


ATE
LME